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NATIONAL DAM SAFETY PROGRAM. NO NAME 548 PFIZER INC. DAM (MO 30--ETC(U)
JUN 79 K B KING, M P FORREST, D R SANDERS DACW43-79-C-0037

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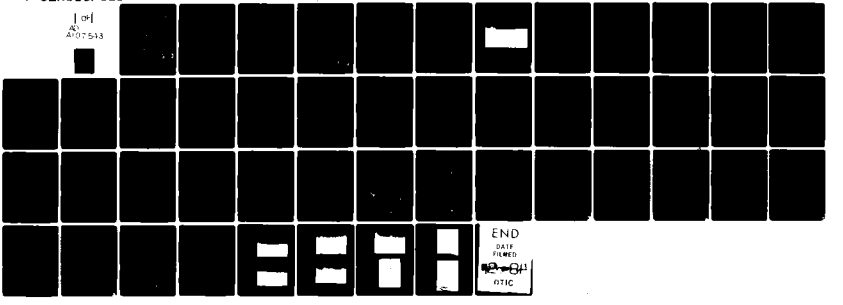
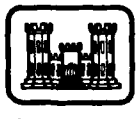


MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

LEVEL II

NO NAME 548 - PFIZER INC. DAM
WASHINGTON COUNTY, MISSOURI
MO 30705

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE 1979

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National Dam Safety Program. No Name 548 Pfizer Inc. Dam (MO 30705), Mississippi - Kaskaskia - St. Louis Basin, Washington County, Missouri. Phase I Inspection Report.

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

13 August 1979

SUBJECT: Pfizer Inc. Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Pfizer Inc. Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of:

1. The spillway can only pass 9 percent of the PMF without significant erosion of the spillway or embankment.

2. Erosion of the open channel spillway through the embankment near the left abutment is taking place in the upstream direction and is encroaching on the toe of the dam.

3. Excessively steep downstream slope.

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

APPROVED BY: _____ _____
Colonel, CE, District Engineer Date

NO NAME 548 - PFIZER INC. DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30705

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JUNE 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	No Name 548 - Pfizer Inc. Dam
State	Missouri
County	Washington
Stream	Tributary to Mill Creek
Date of Inspection	20 March 1979

No Name 548 Dam was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. of San Francisco, California. The dam is owned by Pfizer, Inc. of Potosi, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment was based on an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site to determine if the dam poses hazards to human life or property. The purpose of the dam is to impound tailings from a barite separation and beneficiation operation.

No Name 548 Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these Guidelines, this dam is classified as intermediate size. The U.S. Corps of Engineers has classified it has having a high downstream hazard potential to indicate that failure of this dam could threaten life and property. The damage zone estimated by the U.S. Corps of Engineers extends approximately 11 miles downstream of the dam. Information provided by the Corps of Engineers indicates that 20 dwellings and railroad and highway bridges are within this damage zone.

The results of the inspection and evaluation indicate that the spillway does not meet the criteria given in the Guidelines for a dam with the size and hazard potential of No Name 548 Dam. As an intermediate size dam with a high hazard potential, it is required by the Guidelines to pass the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible in the region. It was calculated that the spillway could pass a 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. It was also estimated that the spillway could pass 9 percent of the PMF without significant erosion of the spillway or embankment. However, the spillway cannot pass 50 percent of the PMF without significant erosion of the spillway and embankment.

The spillway should be constructed and/or adequate freeboard provided so that the PMF can be passed without overtopping the dam. Erosion of the existing spillway is encroaching on the embankment. Adequate erosion protection should be provided so that it can pass the PMF without significant erosion of the embankment and spillway channel.

Seepage and stability analyses of the dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record.

An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam and spillway.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

Michael P. Forrest, P.E.

for Donald R. Sanders, R.G.

VIEW OF NO NAME 548 DAM FROM RIGHT ABUTMENT

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NO NAME 548 - PFIZER INC. DAM
ID NO. 30705

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NATIONAL DAM SAFETY PROGRAM
NO NAME 548 - PFIZER INC. DAM - ID NO. 30705

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the No Name 548 - Pfizer Inc. Dam be made and authorized International Engineering Company, Inc. to make the inspection.

b. Purpose of Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and visual inspection, to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These Guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) No Name 548 Dam is an earthfill dam that is used to impound tailings from a barite separation and beneficiation operation. The tailings consist of red-brown soft silty clay and are overgrown with vegetation. The tailings were deposited as a slurry in a water environment.

(2) The spillway is an open channel that passes through the dam embankment near the left abutment. The spillway is about 4 feet wide at the bottom and has a maximum depth of about 8.5 feet. The spillway discharges into an eroded channel that ultimately leads to Mill Creek. No other outlets or regulating structures were found.

b. Location. The dam is located in the eastern portion of Washington County, Missouri, as shown in Plate 1. The dam (shown in Plate 2) is located in Section 4, Township 37 North, Range 3 East.

c. Size Classification. This dam is greater than 40 feet high and less than 100 feet high and is therefore in the intermediate size classification, according to the "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification. The U.S. Corps of Engineers has classified this dam in the high hazard potential category. The estimated damage zone, as provided by the Corps of Engineers, extends approximately 11 miles downstream of the dam. Several dwellings and railroad and highway bridges are within this damage zone.

e. Ownership. This dam is owned by:

Pfizer, Inc.
Minerals, Pigments and Metals Division
P.O. Box 70
Potosi, Missouri 63664

f. Purpose of Dam. The purpose of the dam is to impound the tailings from a barite separation and beneficiation operation.

g. Design and Construction History. Available information indicates that construction of the dam began in 1954-1955 and was completed in 1968 when mill operations were terminated.

h. Normal Operating Procedure. No operating records are known to exist. The outflow of surface water runoff would pass through an uncontrolled spillway located near the left end of the dam. Tailings are no longer conveyed to the impoundment.

1.3 PERTINENT DATA

Field surveys were made by Booker Associates, Inc. of St. Louis, Missouri on 30 March 1979. The survey data are presented in Plates 3, 4 and 5.

a. Drainage Area - 294 acres (Topographic Quadrangle, 7.5-minute series, Mineral Point, Missouri, 1958).

b. Discharge at Damsite.

(1) Outlet Pipe. There is no outlet pipe at this dam. Not applicable.

(2) Spillway discharge for pool at top of dam (El. 890.0) - 580 cfs.

(3) Maximum experienced outflow at damsite - no available information.

c. Elevation (Feet above M.S.L.).[1/]

(1) Top of dam - Varies from El. 890.0 to El. 899.0.

(2) Spillway crest - El. 884.0.

(3) Streambed at downstream toe of dam - El. 821 ±.

(4) Tailings surface adjacent to dam - Varies from El. 882 ± to El. 889 ±.

d. Reservoir. Length of impoundment - 3500 ± feet (Aerial photograph, scale: 1 inch = 1000 feet).

e. Storage.

(1) Spillway crest (El. 884.0) - 1756 acre-feet.

(2) Top of dam (El. 890.0) - 2200 acre-feet.

f. Reservoir Surface Area.

(1) Spillway crest (El. 884.0) - 68 acres.

(2) Top of dam (El. 890.0) - 80 acres.

g. Dam

(1) Type - Earthfill.

(2) Length - 2700 feet ±.

(3) Height (maximum above streambed) - 75 feet ±.

(4) Top Width - varies from about 15 to 75 feet.

(5) Side Slopes -

(a) Downstream: 1.4(H) to 1.0(V).

(b) Upstream: unknown.

(6) Zoning - The zoning of the dam consists of a clay starter dam, which is overlain by sands and angular gravels. The sands and gravels are generally finer than 3/4-inch.

1/Elevations are based on a reference datum of 900.00 M.S.L. at the temporary bench mark (see Plate 3). This elevation was estimated from the topographic quadrangle.

(7) Cutoff - It is not known if a cutoff was actually constructed.

h. Spillway.

(1) Type - Uncontrolled open channel spillway through the embankment at Station 22+65.

(2) Control section - 4-foot bottom width, 8.5-foot depth, 60-foot top width, and the side slopes are irregular.

(3) Crest elevation - El. 884.0 M.S.L.

(4) Upstream channel - There is no upstream channel.

(5) Downstream channel - V-shaped and clear.

i. Regulating Outlets. None.

j. Diversion Ditches. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design drawings or data were available; however, a drawing showing the pond area in plan and profiles through the pond was available at Pfizer's office near Mineral Point, Missouri. It was apparently used for computing storage capacity. The drawing is entitled "Proposed Tailings Pond for Barytes Wash Plant at Mineral Point", Midwest Mining Company, Potosi, Mo., Drawing No. MD - 390, dated 23 November 1954.

2.2 CONSTRUCTION

Construction of the dam began in 1954-1955 and was completed in 1968 when the mill operations were terminated. No detailed construction information was available. The only information available to the inspection team was in the form of verbal communication with Mr. R. G. Griffey, the owner's representative. He stated that trees and vegetation were not stripped from the foundation prior to fill placement. A cutoff trench that was backfilled with clay and extended to bedrock may have been constructed. This information could not be verified. An earthfill starter dam apparently was constructed. Sands and gravels were subsequently hauled in trucks from the mill and dumped on the dam crest. Bulldozers were used to spread the sands and gravels, and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The centerline of the dam remained approximately at the same position as the embankment was raised above the starter dam. Material on the crest was compacted by construction equipment. The gravels were finer than 3/4-inch, and sand and silt sizes were also present. As the tailings level rose over the years, new spillway channels were constructed uphill, towards the left abutment.

2.3 OPERATION

No operating records are known to exist. The outflow of surface water runoff would pass through an uncontrolled spillway.

2.4 EVALUATION

a. Availability. There are no engineering data available. The only information available to the inspection team was a verbal communication with the owner's representative pertaining to construction.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available; the lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Validity. Not applicable because no design data were available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The dam was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. on 20 March 1979. Mr. R. G. Griffey, a representative of Pfizer met with the team during the inspection. The impoundment contains barite tailings; however, tailings are no longer conveyed to the impoundment. Photographs taken during the inspection are included in this report. The field locations of the photographs are shown in Plate 6.

b. Project Geology. The reservoir area was mapped as underlain by chert dolomite of Cambrian Age. Bedrock was exposed in mined areas in the southwest portion of the watershed. The bedrock is covered by a reddish brown silty clay. Both dam abutments are covered with red-brown clayey soil with gravel and rock fragments.

c. Dam. The plan of the dam is shown in Plate 3. The profile and cross sections of the dam and spillway are shown in Plates 4 and 5.

The dam embankment itself is practically free of vegetation. Some trees were observed to be growing out of the embankment and appeared to be rooted in the foundation. The tailings pond is heavily vegetated with small trees and brush.

No detrimental settlement, depressions, cracks, sinkholes, or animal borrows were observed in the embankment. Some erosion of the old spillway channels downstream of the toe of the dam was observed. Also, erosion was observed in the existing spillway outlet channel, which is encroaching on the downstream toe of the dam.

Three springs were observed to be emerging from the toe of the dam. These springs are located immediately to the south of the spillway, as shown in Plate 3. Spring Nos. 1 and 2 were observed on the date of inspection on 20 March, and Spring No. 3 was noted during a brief visit on 27 March. It was observed during the brief visit that the ponded water on the tailings surface had encroached on the upstream gravel face of the dam due to rain which fell between 20 and 27 March. Spring No. 3 was located at the downstream toe, immediately opposite the ponded water. This spring was apparently being fed by the ponded water. The flow from all three springs was clear. The ground surface at Spring No. 1 was soft. The estimated quantity of flow from the springs is as follows:

	Estimated Flow Rate (gpm)	Date
Spring No. 1	5-10	3-20-79
Spring No. 2	less than 1	3-20-79
Spring No. 3	15-25	3-27-79

The difference in elevation between the dam crest and the tailings surface varies from 2 to 15 feet. The elevation difference from the spillway crest to the low point in the dam crest is 6 feet.

d. Appurtenant Structures. The only appurtenant structure at this dam is the open channel spillway through the embankment near the left abutment at Station 22+65 (see Plate 3). The channel is in clayey soils and no erosion protection is provided. Erosion of the channel is taking place in the upstream direction and is encroaching on the toe of the dam.

e. Reservoir Area. The reservoir area is characterized by a ground surface that slopes gently downward to the east. No evidence of landsliding was observed in the reservoir area. The mined area west of the tailings pond is subject to erosion. Since the ground slope is gentle, it is not expected that much sediment transport due to erosion would occur. The tailings in the impoundment consist of soft silty clay that are overgrown with small trees and brush. The tailings were deposited by hydraulic methods during active mine operations; however, deposition has not occurred since 1968.

There is a potential for back water flooding for a few dwellings located along the road from Mineral Point at the upper end of the tailings pond. These dwellings are in natural drainages to the impoundment and could be affected by high reservoir levels resulting from heavy floods.

f. Downstream Channels. Flow from the spillway would enter a V-shaped 15-foot deep channel. Erosion of the clayey soils probably has been taking place in this channel. About 800 feet downstream from the spillway, the channel joins an unnamed tributary of Mill Creek. This tributary joins Mill Creek about 0.5-mile east of the spillway and about 1000 feet downstream (northeast) of the point where the Missouri-Pacific Railroad crosses Mill Creek.

3.2 EVALUATION

The spillway passes through the embankment and flood discharges could cause erosion of the embankment materials. This erosion would threaten the stability of the dam. The spillway channel itself is also being eroded. Erosion of the downstream channel is progressing in an upstream direction and is encroaching on the toe of the dam.

The embankment is a relatively porous granular structure above the tailings surface. If the water level were to rise above the tailings surface due to flood runoff, there could be significant seepage through the embankment which could adversely affect the stability of the dam.

No slope instability was observed, but the downstream slope is steep (at the angle of repose of the gravel). Its long-term stability cannot be evaluated until seepage and stability analyses are performed. The soft soil condition at Spring No. 1 could adversely affect the stability of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures are known to exist for this dam. Surface water runoff would pass through an uncontrolled spillway channel near the left abutment.

4.2 MAINTENANCE OF DAM

Information available to the inspection team indicates that the dam is not maintained.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities at this dam. Not applicable.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

Information available to the inspection team indicates that there is no warning system for this dam.

4.5 EVALUATION

The behavior of the dam should be monitored periodically to observe any indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam or spillway, or an increase in the volume or turbidity of emerging seepage. A maintenance program should be initiated for the dam and spillway.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam and spillway are presented in Section 1 - Project Information and in the accompanying field survey drawings, Plates 3 through 5. No hydrologic or hydraulic design information is available.

For this evaluation, the watershed drainage area, stream lengths, and reservoir areas were obtained from the 1958, 7-1/2-minute, USGS Mineral Point, Missouri, Quadrangle, which has a 20-foot contour interval. The soil group for this watershed is classified as Clarksville Gravelly Loam, equivalent to a hydrologic soil group B classification, which has a moderate rate of water transmission.

The drainage area, as shown on Plate 2, is about 294 acres (0.46-square mile). Land use and vegetation patterns in the watershed were determined from field observations and aerial photographs of the project area. These patterns are divided into the following categories:

Type of Cover	Approximate Percent of Watershed
Woodlands	43
Old Mined Areas	22
Barren Lands	4
Homesteads and Roads	8
Tailings	23

Based on the above, the estimated curve numbers (CN) weighted for the entire watershed are CN 55 for the antecedent mosture condition (AMC) II condition, and CN 74 for the AMC III condition.

It was assumed that the small road from Mineral Point, which passes the upstream end of the tailings pond, will not deter the travel time or quantity of the flood flows arriving from the upper part of the watershed. The old mined areas and barren lands are mostly abandoned barite mining sites. These areas consist of irregular scars on the topography, with some mining pits as much as 10 feet deep. For the estimation of basin runoff curve numbers, these areas were assigned a lower curve number for the computation of a weighted basin runoff curve number. The basin parameters, such as basin lag time, unit hydrograph, and the probable maximum precipitation, are shown in Appendix A.

Three cross-sections of the spillway channel near the spillway entrance were surveyed and are shown in Plate 4. The spillway section with the smallest sectional flow area was chosen as the control section.

At the spillway entrance, channel geometry does not show any definite weir control section; therefore, the weir flow formula does not apply for the computation of a spillway discharge rating curve. Two methods were employed in deriving the spillway rating curve:

- Critical flows at different critical flow depths were computed using the critical flow formula for trapezoidal channels.
- Manning's equation for uniform flow, using the beginning portion of the spillway slope as the average bottom slope (S = 0.023) and a Manning's "n" of 0.04.

The results computed by the Manning's equation for uniform flow were considered more representative of the flow conditions in the spillway. Computations of the discharge rating curve for flows over the dam crest were made by using the weir flow formula with a weir coefficient of C = 3.0 for the dam crest. The combined discharge rating curve data for flows in the spillway and over the dam crest is shown in Appendix A, under the input data listing as Y4 and Y5 cards, and also in the computer printout.

Field surveys of the tailings adjacent to the dam indicate that the tailings vary from about El. 882 to El. 889 (see Plate 3), with an estimated average at El. 884. The storage capacity below El. 884 is considered inactive or dead storage. The reservoir area-capacity curve data are shown in Appendix A. The capacities shown, as computed by the Conic Method in the computer program, are the capacities above the minimum elevation (El. 880) that were entered as input and are not the total reservoir capacities at the given elevations.

b. Experience Data. Recorded rainfall, runoff or other experience data are not available. There is no available evidence of overtopping of the dam.

c. Visual Observations. The open channel spillway is located through the embankment at Station 22+65. Tailings near the spillway were approximately at the same elevation as the approach channel. Specific information on the visual observations is presented in Section 3 - Visual Inspection.

d. Overtopping Potential. The 100-year flood, probable maximum flood (PMF), and floods expressed as percentages of the PMF were computed and routed through the reservoir and spillway. The PMF is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible at a particular location or region. The Modified Puls Method of spillway routing was employed. For all cases of the spillway flood routing, the level of the reservoir surface was set at

El. 884 (the average elevation of the tailings) at the start of the flood routing. It was assumed that erosion of the earth channel and/or spillway-embankment section will not occur as flood discharges increase; therefore, the spillway discharge rating curve was computed for a specific cross-section and configuration.

Results of the overtopping analyses indicate that the spillway is able to pass the 100-year flood. Routing studies indicate that the spillway can also pass about 88 percent of the PMF without overtopping the embankment. However, at 88 percent PMF, the peak spillway outflow is about 580 cfs, with a flow depth of 4.5 feet and flow velocity of about 10 feet per second. High discharge velocities such as those at 88 percent PMF peak outflow could cause significant erosion of the spillway and embankment.

A major consideration in evaluating the safety of the dam is assessing the potential for overtopping and the subsequent failure of the embankment as a result of erosion. Since the spillway is composed of erodible materials, high velocity discharges through the spillway will lead to significant erosion of the spillway and embankment even if the dam is not overtopped. Based on the Corps of Engineers Manual EM 1110-2-1601, "Hydraulic Design of Flood Control Channels", the maximum permissible velocity for the materials found in the spillway section is about 3.5 feet per second. Using this as a criterion, the spillway can pass the 100-year flood. The results of the studies also indicate that the spillway can pass about 9 percent of the PMF without significant erosion. The 9 percent PMF routed outflow is 15 cfs, with a flow depth of 0.6 feet. Thus, for determining the spillway erosion potential, flow velocities in the spillway channel higher than 3.5 feet per second or reservoir water surface elevation exceeding El. 884.8 are considered to produce the effects of embankment failure.

The results of the overtopping analyses are reported in Appendix A and are summarized on the following page.

Flood	Peak Inflow (cfs)	Peak Outflow (cfs)	Max Res WS Elev (ft)	Spillway Flow Depth ft)	Spillway Flow Velocity (ft/sec)	Duration Spillway Vel. over 3.5 ft/sec (hr)
5% PMF	175	6	884.5	0.4	2.5	-
10% PMF	350	20	884.9	0.7*	3.7*	7.2
30% PMF	1050	105	886.6	2.0*	6.5*	12.8
50% PMF	1750	272	887.9	3.1*	8.1*	14.9
75% PMF	2626	496	889.4	4.1*	9.6*	15.6
PMF	3501	1021	890.4**	4.9**	10.6**	18.2

* These flow depths and velocities are considered to produce the effects of significant erosion.

** Dam overtopped (Minimum Dam Crest El. = 890 feet).

Note: Reservoir water surface elevations include the velocity heads corresponding to the velocities computed at the spillway control section.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. The conditions that may adversely affect the structural stability of this dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Operating Records. No appurtenant structures requiring operation exist at this dam, and no records were located.

d. Post-Construction Changes. No post-construction changes were apparent.

e. Seismic Stability. The dam is located in Seismic Zone 2, as defined in the Uniform Building Code. Some crest settlement and ravelling of the gravels could occur during seismic shaking because the gravels are loose and the downstream slope is at or near the natural angle of repose.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. There are several deficiencies that should be corrected. (1) No erosion protection has been provided in the spillway channel. Erosion of the channel is progressing upstream and is encroaching on the embankment. (2) The discharge capacity of the spillway was computed to be inadequate to pass 50 percent of the Probable Maximum Flood (PMF) without significant erosion of the spillway and embankment. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible in the region. The "Recommended Guidelines for Safety Inspection of Dams" specify that the spillway design flood for this dam should be the PMF. (3) The springs at the toe of the dam and the soft soil conditions at one of these springs could adversely affect the stability of the dam. (4) Seepage and stability analyses were not available and they should be made a matter of record.

b. Adequacy of Information. No detailed design or construction data were available. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, and this lack of data is considered a deficiency.

Results of the hydrologic studies could be changed if larger scale topographic maps with smaller contour intervals were used. The only available topographic map is the 7.5-minute, 1:24,000 scale USGS quadrangle with a 20-foot contour interval. All measurements made on this map, such as drainage area, stream lengths, river slopes, and reservoir area-capacity data are insufficient in details, but the map suffices for the Phase I inspection. The use of the USGS quadrangle for the hydrologic studies results in an approximate evaluation of the spillway flood discharge capacity.

c. Urgency. The Phase I inspection indicated apparent deficiencies in the condition of the dam and spillway. Initiation of measures to increase the spillway capacity and provide the spillway with adequate erosion protection should be given priority.

d. Necessity for Phase II. No Phase II investigation is recommended; however, additional investigative work should be done as necessary so that seepage and stability analyses can be performed. The investigations should be undertaken by a professional engineer experienced in the design and construction of tailings dams.

7.2 REMEDIAL MEASURES

The following remedial measures are recommended:

a. Preferably, the spillway should be relocated in the left abutment, and the existing spillway through the embankment should be plugged. Adequate erosion protection should be provided on the spillway channel

bottom and side slopes. Erosion protection should also be provided on the upstream face of the dam adjacent to the spillway. The erosion protection should be adequate to withstand the peak discharge velocity resulting from the PMF.

b. The existing spillway capacity was calculated to be adequate to pass 9 percent of the PMF without significant erosion of the spillway and embankment and without overtopping the dam. To comply with the Guidelines for a dam of this size and hazard potential, the spillway should be constructed and/or the freeboard increased so that the PMF can be passed without overtopping the dam crest and without significant erosion of the spillway or embankment.

c. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of tailings dams. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam. Based on the results of the stability studies, remedial measures may become necessary. All remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

d. Specific remedial work should be addressed to conducting the water from the springs away from the toe of the dam so that ponding will not occur.

e. An inspection and maintenance program should be initiated. Periodic inspections should be made by qualified personnel to observe the performance of the dam and spillway. Observations should include indications of instability, such as cracks in the embankment, sloughing, erosion, sudden settlement, or an increase in the volume or turbidity of the spring areas. Records should be kept of these inspections and of any corrective maintenance made to the dam and spillway.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Unit Hydrograph - The Soil Conservation Service (SCS) curvelinear unit hydrograph method was used. Basin lag time was computed by using the SCS Curve Number Method and equation.

- Hydrologic Soil Group, Antecedent Moisture Condition (AMC) and Curve Number (CN) - The predominant hydrologic soil group for the watershed was obtained from an agricultural soil classification map prepared by the University of Missouri Agricultural Experiment Station. For the PMF and floods expressed as a percent of PMF, AMC III conditions were used. For the 100-year and/or 10-year floods, AMC II conditions were assumed. Watershed CN was estimated from field observations and from aerial photos.

- Reservoir Area-Capacity - Areas were measured from U.S.G.S. topographic maps. Reservoir elevations and corresponding surface areas were input in the computer program, which determined the reservoir capacities by the Conic Method.

- Reservoir and Spillway Flood Routing - The Modified Puls Method was used for all flood routing through spillway and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the computer program "Users Manual", September 1978, and are not explained herein.

```
A1          PFISER TAILINGS DAM  MO. NO.  30705
A2          HEC-1  PHASE I  DAM SAFETY INVESTIGATIONS
A3          RATIOS OF PMF ROUTED THROUGH RESERVOIR
B    288                  5                                                  2
B1     5
J      1          6        1
J1   .05        .10      .30       .50       .75       1.0
K      0     INFLOW                                     1
M      1          2      .46                          1                     1
P      0       25.8      102       120       130
T                                                                -1        -74
W2              .46
X    -10        -.1      2.5
K      1       LAKE                          1         1
Y                                     1         1
Y1     1                                                        -884        -1
Y4   884       884.6      886     887.3     888.7     890.1     891.5       892       893     894.4
Y5                 8       58       165       400       590      2400      4110     11710     31750
$A    62        65        68        72        76        80        90       100
$E   880       882       884       886       888       890       895       900
$S   884
$D   890
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/05/23.
     TIME= 10.13.01.
```

PFISER TAILINGS DAM MO. NO. 30705
HEC-1 PHASE I DAM SAFETY INVESTIGATIONS
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	2	0
			JOPER	NRT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .05 .10 .30 .50 .75 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW		0	0	0	0	1	0	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.46	0.00	.46	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.80	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-78.00	0.00	0.00

CURVE NO = -78.00 WETNESS = -1.00 EFFECT CN = 78.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .46

RECESSION DATA
STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

UNIT HYDROGRAPH 30 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .46 VOL= 1.00

34.	101.	207.	338.	420.	443.	422.	371.	303.	221.
166.	126.	98.	75.	57.	44.	33.	25.	19.	15.
11.	9.	6.	5.	4.	3.	2.	2.	1.	0.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.18	.04	190.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.18	.03	208.
1.01	.15	3	.01	0.00	.01	3.	1.01	12.15	147	.22	.19	.03	232.
1.01	.20	4	.01	0.00	.01	3.	1.01	12.20	148	.22	.19	.03	277.
1.01	.25	5	.01	0.00	.01	3.	1.01	12.25	149	.22	.19	.03	333.
1.01	.30	6	.01	0.00	.01	3.	1.01	12.30	150	.22	.19	.03	392.
1.01	.35	7	.01	0.00	.01	2.	1.01	12.35	151	.22	.19	.03	450.
1.01	.40	8	.01	0.00	.01	2.	1.01	12.40	152	.22	.19	.03	501.
1.01	.45	9	.01	0.00	.01	2.	1.01	12.45	153	.22	.19	.03	544.
1.01	.50	10	.01	0.00	.01	2.	1.01	12.50	154	.22	.20	.02	576.
1.01	.55	11	.01	0.00	.01	2.	1.01	12.55	155	.22	.20	.02	602.
1.01	1.00	12	.01	0.00	.01	2.	1.01	13.00	156	.22	.20	.02	622.
1.01	1.05	13	.01	0.00	.01	1.	1.01	13.05	157	.26	.24	.03	640.
1.01	1.10	14	.01	0.00	.01	1.	1.01	13.10	158	.26	.24	.02	658.
1.01	1.15	15	.01	0.00	.01	1.	1.01	13.15	159	.26	.24	.02	677.
1.01	1.20	16	.01	0.00	.01	1.	1.01	13.20	160	.26	.24	.02	700.
1.01	1.25	17	.01	0.00	.01	1.	1.01	13.25	161	.26	.24	.02	725.
1.01	1.30	18	.01	0.00	.01	1.	1.01	13.30	162	.26	.24	.02	749.
1.01	1.35	19	.01	0.00	.01	1.	1.01	13.35	163	.26	.24	.02	772.
1.01	1.40	20	.01	0.00	.01	1.	1.01	13.40	164	.26	.24	.02	792.
1.01	1.45	21	.01	0.00	.01	1.	1.01	13.45	165	.26	.24	.02	809.
1.01	1.50	22	.01	0.00	.01	1.	1.01	13.50	166	.26	.25	.02	823.
1.01	1.55	23	.01	0.00	.01	1.	1.01	13.55	167	.26	.25	.02	836.
1.01	2.00	24	.01	0.00	.01	1.	1.01	14.00	168	.26	.25	.02	848.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.05	169	.33	.31	.02	858.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.10	170	.33	.31	.02	865.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.15	171	.33	.31	.02	873.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.20	172	.33	.31	.02	908.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.25	173	.33	.31	.02	958.
1.01	2.30	30	.01	0.00	.01	0.	1.01	14.30	174	.33	.31	.02	970.
1.01	2.35	31	.01	0.00	.01	0.	1.01	14.35	175	.33	.31	.02	999.
1.01	2.40	32	.01	0.00	.01	0.	1.01	14.40	176	.33	.31	.01	1025.
1.01	2.45	33	.01	0.00	.01	0.	1.01	14.45	177	.33	.32	.01	1047.
1.01	2.50	34	.01	0.00	.01	0.	1.01	14.50	178	.33	.32	.01	1066.
1.01	2.55	35	.01	0.00	.01	0.	1.01	14.55	179	.33	.32	.01	1077.
1.01	3.00	36	.01	0.00	.01	0.	1.01	15.00	180	.33	.32	.01	1087.
1.01	3.05	37	.01	0.00	.01	0.	1.01	15.05	181	.20	.19	.01	1091.
1.01	3.10	38	.01	0.00	.01	0.	1.01	15.10	182	.40	.39	.01	1092.
1.01	3.15	39	.01	0.00	.01	0.	1.01	15.15	183	.40	.39	.01	1092.
1.01	3.20	40	.01	0.00	.01	0.	1.01	15.20	184	.60	.58	.02	1101.
1.01	3.25	41	.01	0.00	.01	0.	1.01	15.25	185	.70	.68	.02	1161.
1.01	3.30	42	.01	0.00	.01	0.	1.01	15.30	186	1.70	1.65	.05	1293.
1.01	3.35	43	.01	0.00	.01	0.	1.01	15.35	187	2.80	2.74	.06	1510.
1.01	3.40	44	.01	0.00	.01	0.	1.01	15.40	188	1.10	1.08	.02	1918.
1.01	3.45	45	.01	0.00	.01	0.	1.01	15.45	189	.70	.69	.01	2453.
1.01	3.50	46	.01	0.00	.01	0.	1.01	15.50	190	.60	.59	.01	3001.
1.01	3.55	47	.01	0.00	.01	0.	1.01	15.55	191	.40	.39	.01	3366.
1.01	4.00	48	.01	0.00	.01	0.	1.01	16.00	192	.40	.39	.01	3501.
1.01	4.05	49	.01	0.00	.01	0.	1.01	16.05	193	.31	.30	.00	3429.
1.01	4.10	50	.01	.00	.01	0.	1.01	16.10	194	.31	.30	.00	3201.
1.01	4.15	51	.01	.00	.01	0.	1.01	16.15	195	.31	.30	.00	2869.
1.01	4.20	52	.01	.00	.01	0.	1.01	16.20	196	.31	.30	.00	2500.
1.01	4.25	53	.01	.00	.01	0.	1.01	16.25	197	.31	.30	.00	2188.
1.01	4.30	54	.01	.00	.01	0.	1.01	16.30	198	.31	.30	.00	1937.
1.01	4.35	55	.01	.00	.01	0.	1.01	16.35	199	.31	.30	.00	1791.
1.01	4.40	56	.01	.00	.01	1.	1.01	16.40	200	.31	.30	.00	1585.
1.01	4.45	57	.01	.00	.01	1.	1.01	16.45	201	.31	.30	.00	1468.
1.01	4.50	58	.01	.00	.01	1.	1.01	16.50	202	.31	.30	.00	1372.

1.01	4.55	59	.01	.00	.01	1.	1.01	16.55	203	.31	.30	.00	1302.
1.01	5.00	60	.01	.00	.01	2.	1.01	17.00	204	.31	.30	.00	1249.
1.01	5.05	61	.01	.00	.01	2.	1.01	17.05	205	.24	.24	.00	1206.
1.01	5.10	62	.01	.00	.01	2.	1.01	17.10	206	.24	.24	.00	1169.
1.01	5.15	63	.01	.00	.01	3.	1.01	17.15	207	.24	.24	.00	1133.
1.01	5.20	64	.01	.00	.01	3.	1.01	17.20	208	.24	.24	.00	1093.
1.01	5.25	65	.01	.00	.01	3.	1.01	17.25	209	.24	.24	.00	1052.
1.01	5.30	66	.01	.00	.01	4.	1.01	17.30	210	.24	.24	.00	1013.
1.01	5.35	67	.01	.00	.01	4.	1.01	17.35	211	.24	.24	.00	979.
1.01	5.40	68	.01	.00	.01	5.	1.01	17.40	212	.24	.24	.00	948.
1.01	5.45	69	.01	.00	.01	5.	1.01	17.45	213	.24	.24	.00	923.
1.01	5.50	70	.01	.00	.01	5.	1.01	17.50	214	.24	.24	.00	904.
1.01	5.55	71	.01	.00	.01	6.	1.01	17.55	215	.24	.24	.00	890.
1.01	6.00	72	.01	.00	.01	6.	1.01	18.00	216	.24	.24	.00	878.
1.01	6.05	73	.06	.01	.05	7.	1.01	18.05	217	.02	.02	.00	863.
1.01	6.10	74	.06	.01	.05	8.	1.01	18.10	218	.02	.02	.00	836.
1.01	6.15	75	.06	.01	.05	10.	1.01	18.15	219	.02	.02	.00	787.
1.01	6.20	76	.06	.02	.05	14.	1.01	18.20	220	.02	.02	.00	711.
1.01	6.25	77	.06	.02	.05	19.	1.01	18.25	221	.02	.02	.00	617.
1.01	6.30	78	.06	.02	.05	26.	1.01	18.30	222	.02	.02	.00	519.
1.01	6.35	79	.06	.02	.04	32.	1.01	18.35	223	.02	.02	.00	426.
1.01	6.40	80	.06	.02	.04	39.	1.01	18.40	224	.02	.02	.00	348.
1.01	6.45	81	.06	.02	.04	45.	1.01	18.45	225	.02	.02	.00	318.
1.01	6.50	82	.06	.02	.04	51.	1.01	18.50	226	.02	.02	.00	290.
1.01	6.55	83	.06	.03	.04	57.	1.01	18.55	227	.02	.02	.00	264.
1.01	7.00	84	.06	.03	.04	62.	1.01	19.00	228	.02	.02	.00	241.
1.01	7.05	85	.06	.03	.04	67.	1.01	19.05	229	.02	.02	.00	220.
1.01	7.10	86	.06	.03	.04	72.	1.01	19.10	230	.02	.02	.00	201.
1.01	7.15	87	.06	.03	.03	77.	1.01	19.15	231	.02	.02	.00	183.
1.01	7.20	88	.06	.03	.03	82.	1.01	19.20	232	.02	.02	.00	167.
1.01	7.25	89	.06	.03	.03	86.	1.01	19.25	233	.02	.02	.00	153.
1.01	7.30	90	.06	.03	.03	90.	1.01	19.30	234	.02	.02	.00	139.
1.01	7.35	91	.06	.03	.03	94.	1.01	19.35	235	.02	.02	.00	127.
1.01	7.40	92	.06	.03	.03	98.	1.01	19.40	236	.02	.02	.00	116.
1.01	7.45	93	.06	.03	.03	101.	1.01	19.45	237	.02	.02	.00	106.
1.01	7.50	94	.06	.04	.03	105.	1.01	19.50	238	.02	.02	.00	97.
1.01	7.55	95	.06	.04	.03	108.	1.01	19.55	239	.02	.02	.00	88.
1.01	8.00	96	.06	.04	.03	111.	1.01	20.00	240	.02	.02	.00	80.
1.01	8.05	97	.06	.04	.03	115.	1.01	20.05	241	.02	.02	.00	78.
1.01	8.10	98	.06	.04	.03	117.	1.01	20.10	242	.02	.02	.00	77.
1.01	8.15	99	.06	.04	.03	120.	1.01	20.15	243	.02	.02	.00	76.
1.01	8.20	100	.06	.04	.03	123.	1.01	20.20	244	.02	.02	.00	76.
1.01	8.25	101	.06	.04	.02	126.	1.01	20.25	245	.02	.02	.00	76.
1.01	8.30	102	.06	.04	.02	128.	1.01	20.30	246	.02	.02	.00	76.
1.01	8.35	103	.06	.04	.02	131.	1.01	20.35	247	.02	.02	.00	76.
1.01	8.40	104	.06	.04	.02	133.	1.01	20.40	248	.02	.02	.00	76.
1.01	8.45	105	.06	.04	.02	135.	1.01	20.45	249	.02	.02	.00	76.
1.01	8.50	106	.06	.04	.02	137.	1.01	20.50	250	.02	.02	.00	76.
1.01	8.55	107	.06	.04	.02	140.	1.01	20.55	251	.02	.02	.00	76.
1.01	9.00	108	.06	.04	.02	142.	1.01	21.00	252	.02	.02	.00	76.
1.01	9.05	109	.06	.04	.02	144.	1.01	21.05	253	.02	.02	.00	76.
1.01	9.10	110	.06	.04	.02	146.	1.01	21.10	254	.02	.02	.00	76.
1.01	9.15	111	.06	.04	.02	147.	1.01	21.15	255	.02	.02	.00	76.
1.01	9.20	112	.06	.05	.02	149.	1.01	21.20	256	.02	.02	.00	74.
1.01	9.25	113	.06	.05	.02	151.	1.01	21.25	257	.02	.02	.00	76.
1.01	9.30	114	.06	.05	.02	153.	1.01	21.30	258	.02	.02	.00	76.
1.01	9.35	115	.06	.05	.02	154.	1.01	21.35	259	.02	.02	.00	76.
1.01	9.40	116	.06	.05	.02	156.	1.01	21.40	260	.02	.02	.00	76.
1.01	9.45	117	.06	.05	.02	157.	1.01	21.45	261	.02	.02	.00	76.
1.01	9.50	118	.06	.05	.02	159.	1.01	21.50	262	.02	.02	.00	76.

1.01	9.55	119	.06	.05	.02	160.	1.01	21.55	263	.02	.02	.00	76.
1.01	10.00	120	.06	.05	.02	162.	1.01	22.00	264	.02	.02	.00	76.
1.01	10.05	121	.06	.05	.02	163.	1.01	22.05	265	.02	.02	.00	76.
1.01	10.10	122	.06	.05	.02	164.	1.01	22.10	266	.02	.02	.00	76.
1.01	10.15	123	.06	.05	.02	165.	1.01	22.15	267	.02	.02	.00	76.
1.01	10.20	124	.06	.05	.02	167.	1.01	22.20	268	.02	.02	.00	76.
1.01	10.25	125	.06	.05	.02	168.	1.01	22.25	269	.02	.02	.00	76.
1.01	10.30	126	.06	.05	.01	169.	1.01	22.30	270	.02	.02	.00	76.
1.01	10.35	127	.06	.05	.01	170.	1.01	22.35	271	.02	.02	.00	76.
1.01	10.40	128	.06	.05	.01	171.	1.01	22.40	272	.02	.02	.00	76.
1.01	10.45	129	.06	.05	.01	172.	1.01	22.45	273	.02	.02	.00	76.
1.01	10.50	130	.06	.05	.01	173.	1.01	22.50	274	.02	.02	.00	76.
1.01	10.55	131	.06	.05	.01	174.	1.01	22.55	275	.02	.02	.00	76.
1.01	11.00	132	.06	.05	.01	175.	1.01	23.00	276	.02	.02	.00	76.
1.01	11.05	133	.06	.05	.01	176.	1.01	23.05	277	.02	.02	.00	76.
1.01	11.10	134	.06	.05	.01	177.	1.01	23.10	278	.02	.02	.00	76.
1.01	11.15	135	.06	.05	.01	178.	1.01	23.15	279	.02	.02	.00	76.
1.01	11.20	136	.06	.05	.01	179.	1.01	23.20	280	.02	.02	.00	76.
1.01	11.25	137	.06	.05	.01	180.	1.01	23.25	281	.02	.02	.00	76.
1.01	11.30	138	.06	.05	.01	181.	1.01	23.30	282	.02	.02	.00	76.
1.01	11.35	139	.06	.05	.01	182.	1.01	23.35	283	.02	.02	.00	76.
1.01	11.40	140	.06	.05	.01	182.	1.01	23.40	284	.02	.02	.00	76.
1.01	11.45	141	.06	.05	.01	183.	1.01	23.45	285	.02	.02	.00	76.
1.01	11.50	142	.06	.05	.01	184.	1.01	23.50	286	.02	.02	.00	76.
1.01	11.55	143	.06	.05	.01	185.	1.01	23.55	287	.02	.02	.00	76.
1.01	12.00	144	.06	.05	.01	185.	1.02	0.00	288	.02	.02	.00	76.
									SUM	33.54	29.66	3.88	105898.
										(852.)	(753.)	(98.)	(2998.70)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3501.	1221.	368.	368.	105858.
CMS	99.	35.	10.	10.	2998.
INCHES		24.69	29.73	29.73	29.73
MM		627.06	755.19	755.19	755.19
AC-FT		605.	729.	729.	729.
THOUS CU M		747.	899.	899.	899.

HYDROGRAPH ROUTING

	ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	LAKE	1	0	0	1	1	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0
	NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-884.	-1

STAGE	884.00	884.60	886.00	887.30	888.70	890.10	891.50	892.00	893.00	894.40
FLOW	0.00	0.00	58.00	165.00	400.00	590.00	2400.00	4110.00	11710.00	31750.00
SURFACE AREA=	62.	65.	68.	72.	76.	80.	90.	100.		
CAPACITY=	0.	127.	260.	400.	548.	704.	1129.	1603.		
ELEVATION=	880.	882.	884.	886.	888.	890.	895.	900.		

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
884.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
890.0	0.0	0.0	0.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

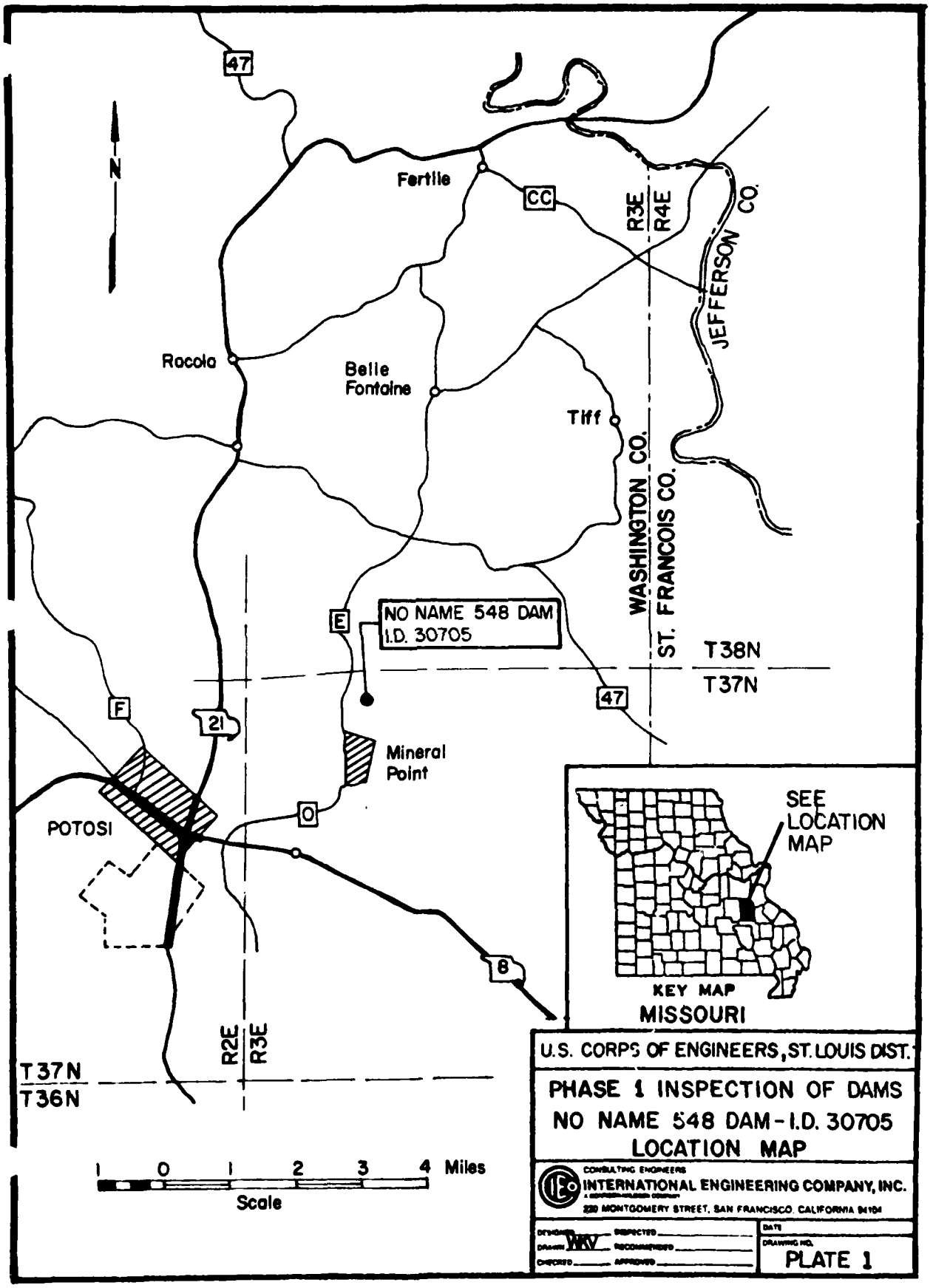
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .05	RATIO 2 .10	RATIO 3 .30	RATIO 4 .50	RATIO 5 .75	RATIO 6 1.00
HYDROGRAPH AT	INFLOW	.46	1	175.	350.	1050.	1750.	2626.	3501.
		(1.19)		(4.96)(	9.91)(	29.74)(	49.57)(	74.35)(	99.14)(
ROUTED TO	LAKE	.46	1	6.	20.	105.	272.	496.	1021.
		(1.19)		(.18)(	.56)(	2.98)(	7.71)(	14.04)(	28.91)(

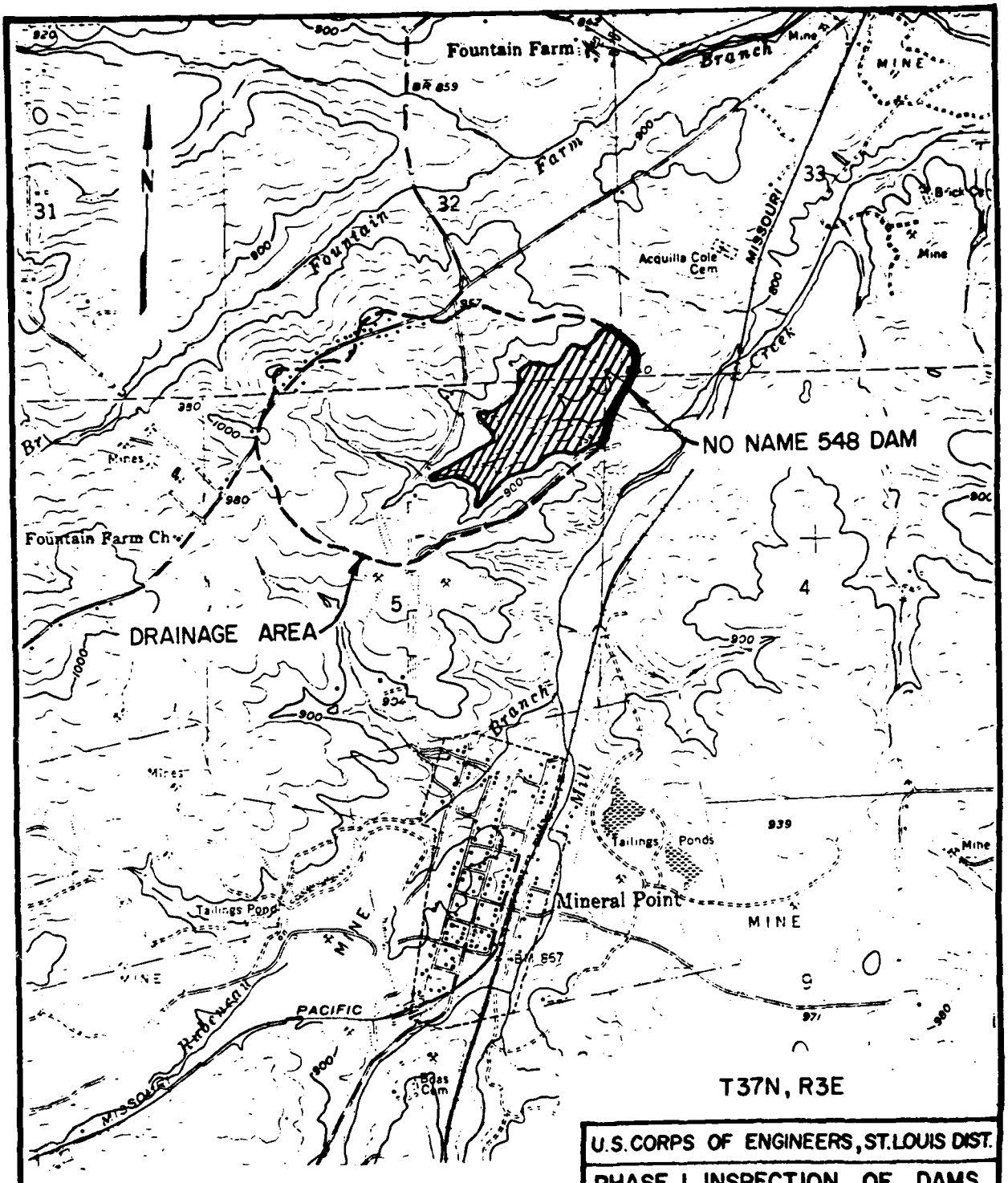
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	884.00	884.00	890.00
STORAGE	260.	260.	704.
OUTFLOW	0.	0.	576.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	884.88	0.00	293.	6.	0.00	19.58	0.00
.10	884.93	0.00	324.	20.	0.00	19.17	0.00
.30	886.57	0.00	442.	105.	0.00	18.67	0.00
.50	887.94	0.00	543.	272.	0.00	18.50	0.00
.75	889.41	0.00	657.	496.	0.00	18.42	0.00
1.00	890.43	.43	739.	1021.	2.75	17.50	0.00


47
N
Fertile
CC
R3E
R4E
JEFFERSON CO.
Rocola
Belle Fontaine
Tiff
WASHINGTON CO.
ST. FRANCOIS CO.
NO NAME 548 DAM
I.D. 30705
E
T38N
T37N
47
F
21
Mineral Point
O
POTOSI
8
R2E
R3E
T37N
T36N
1 0 1 2 3 4 Miles
Scale
SEE LOCATION MAP
KEY MAP
MISSOURI
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.
PHASE 1 INSPECTION OF DAMS
NO NAME 548 DAM - I.D. 30705
LOCATION MAP
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104
DESIGNED
DRAWN WKV
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DRAWING NO.
PLATE 1

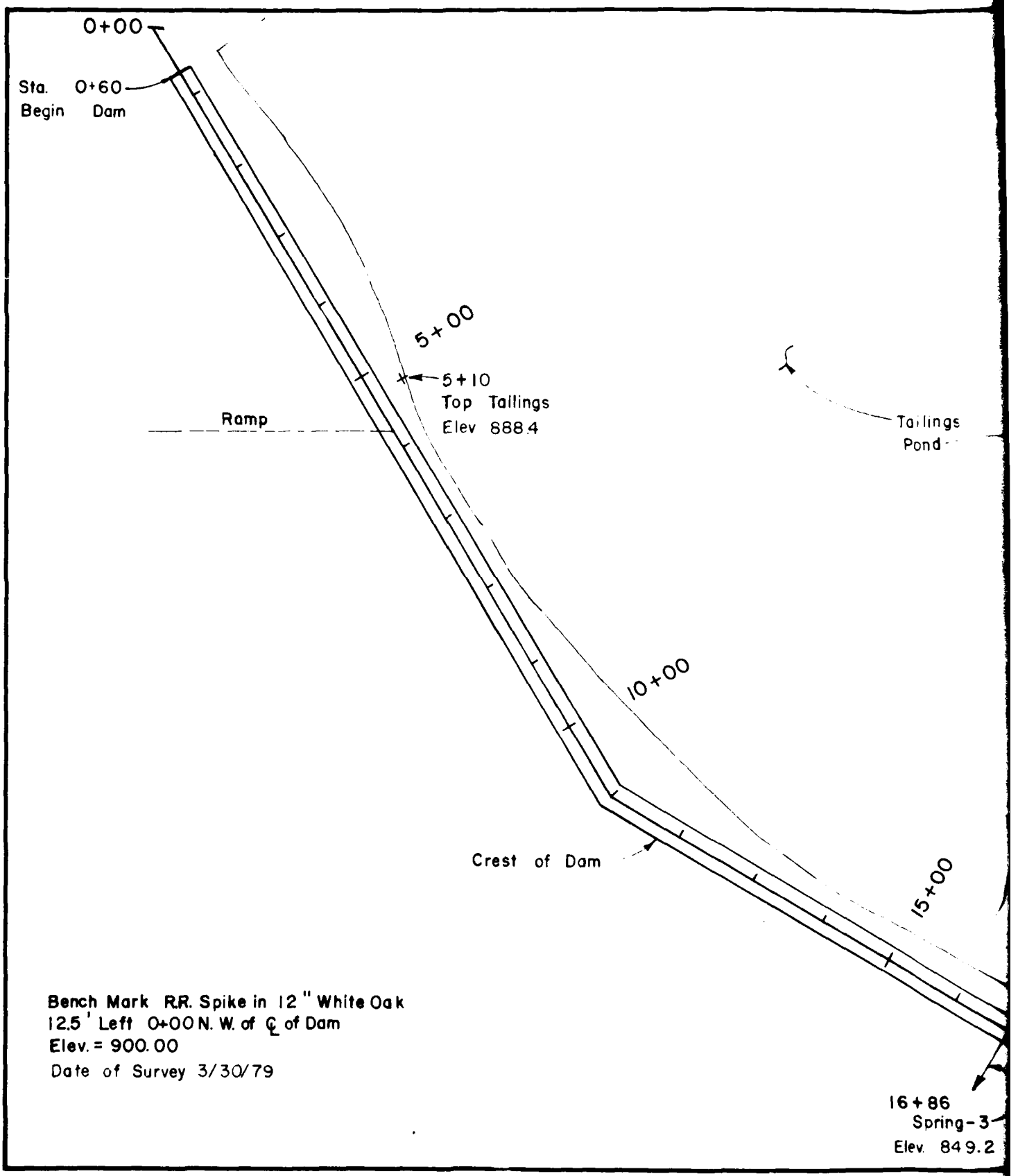


U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NO NAME 548 DAM - I.D. 30705
VICINITY TOPOGRAPHY

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED _____ INSPECTED _____
DRAWN _____ RECOMMENDED _____
CHECKED _____ APPROVED _____
DATE
DRAWING NO.
PLATE 2


0+00
Sta. 0+60
Begin Dam
5+00
5+10
Top Tailings
Elev 888.4
Ramp
Tailings
Pond
10+00
Crest of Dam
15+00
16+86
Spring-3
Elev. 849.2
Bench Mark R.R. Spike in 12" White Oak
12.5' Left 0+00 N. W. of ℄ of Dam
Elev. = 900.00
Date of Survey 3/30/79

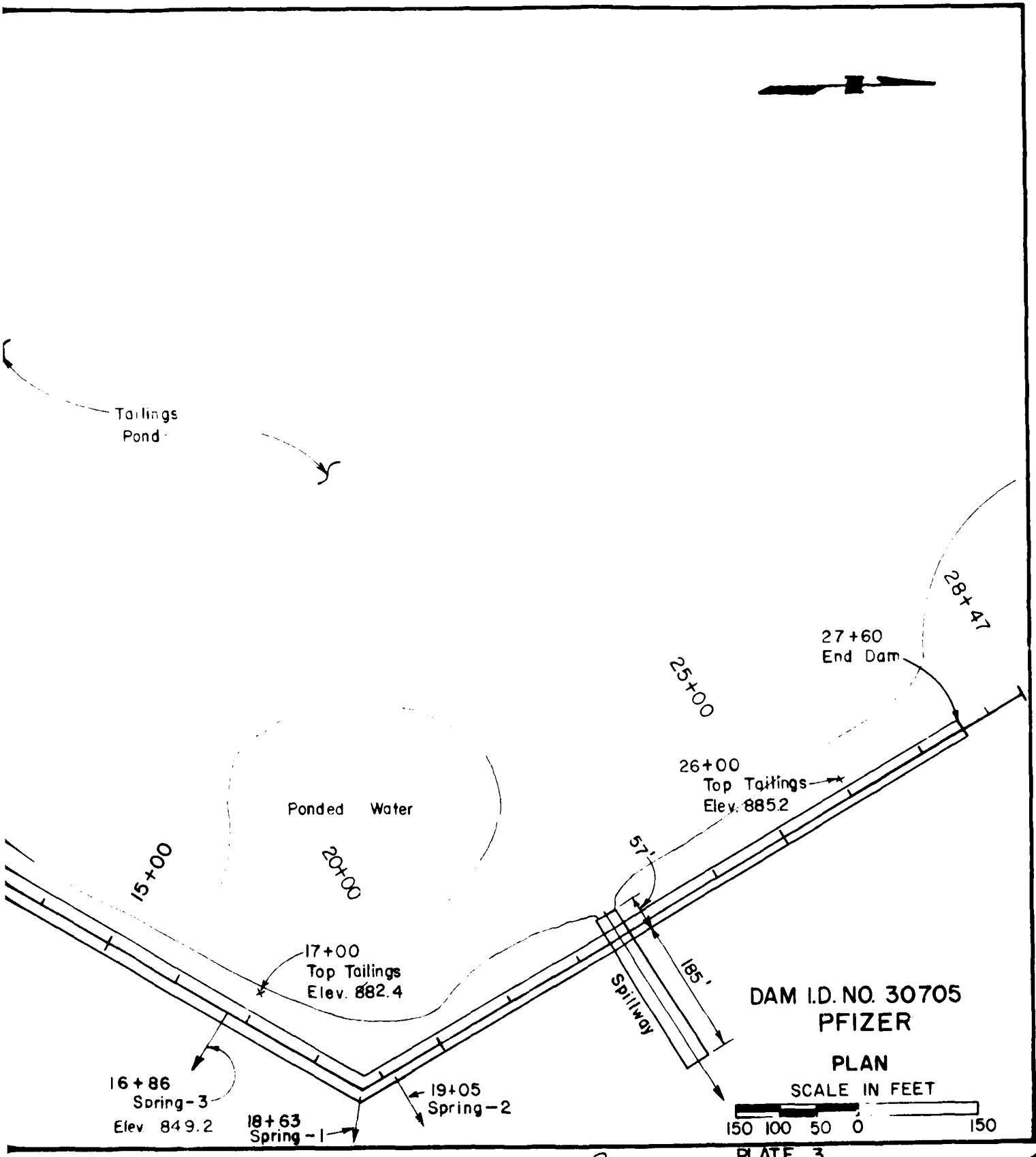
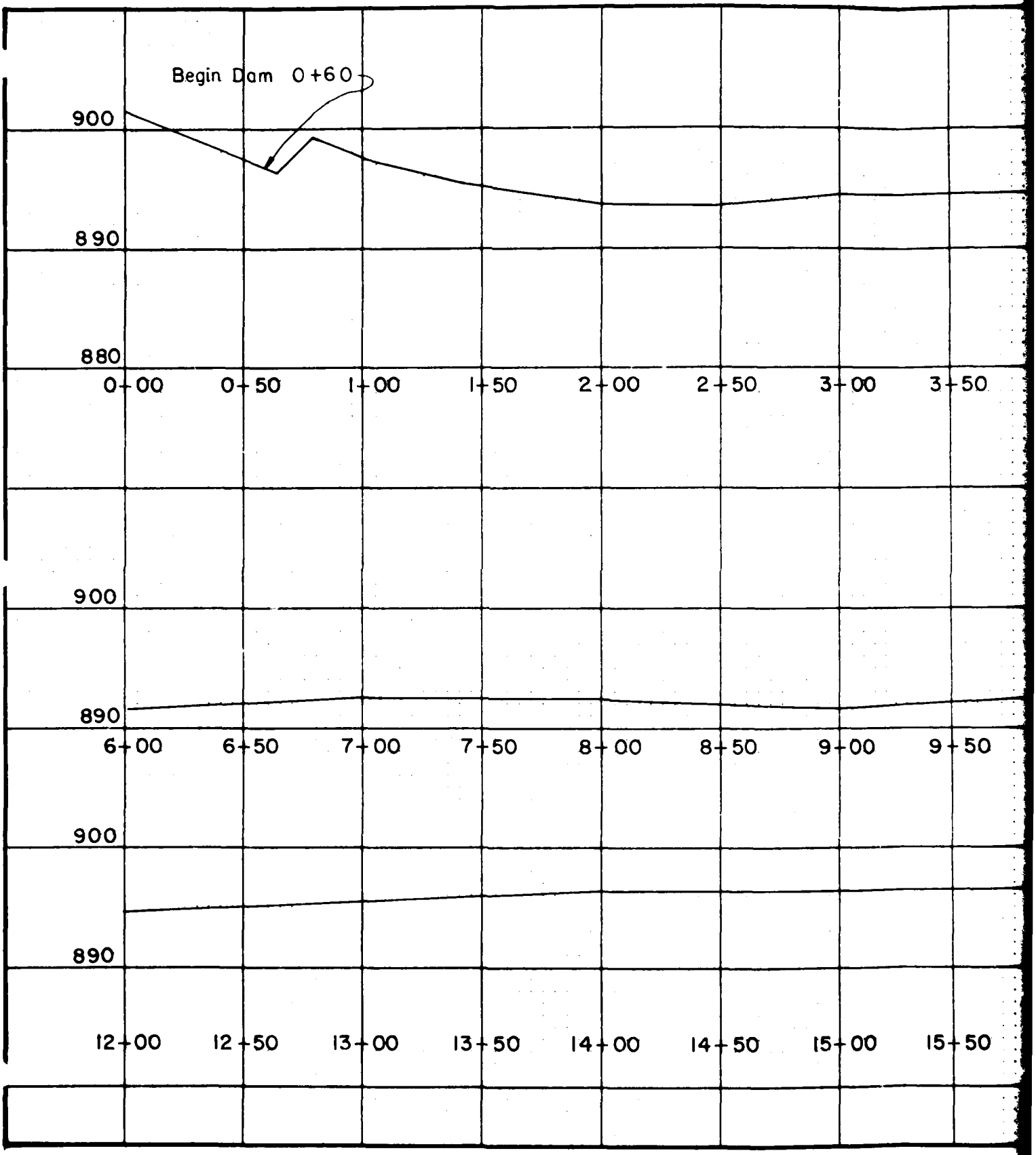
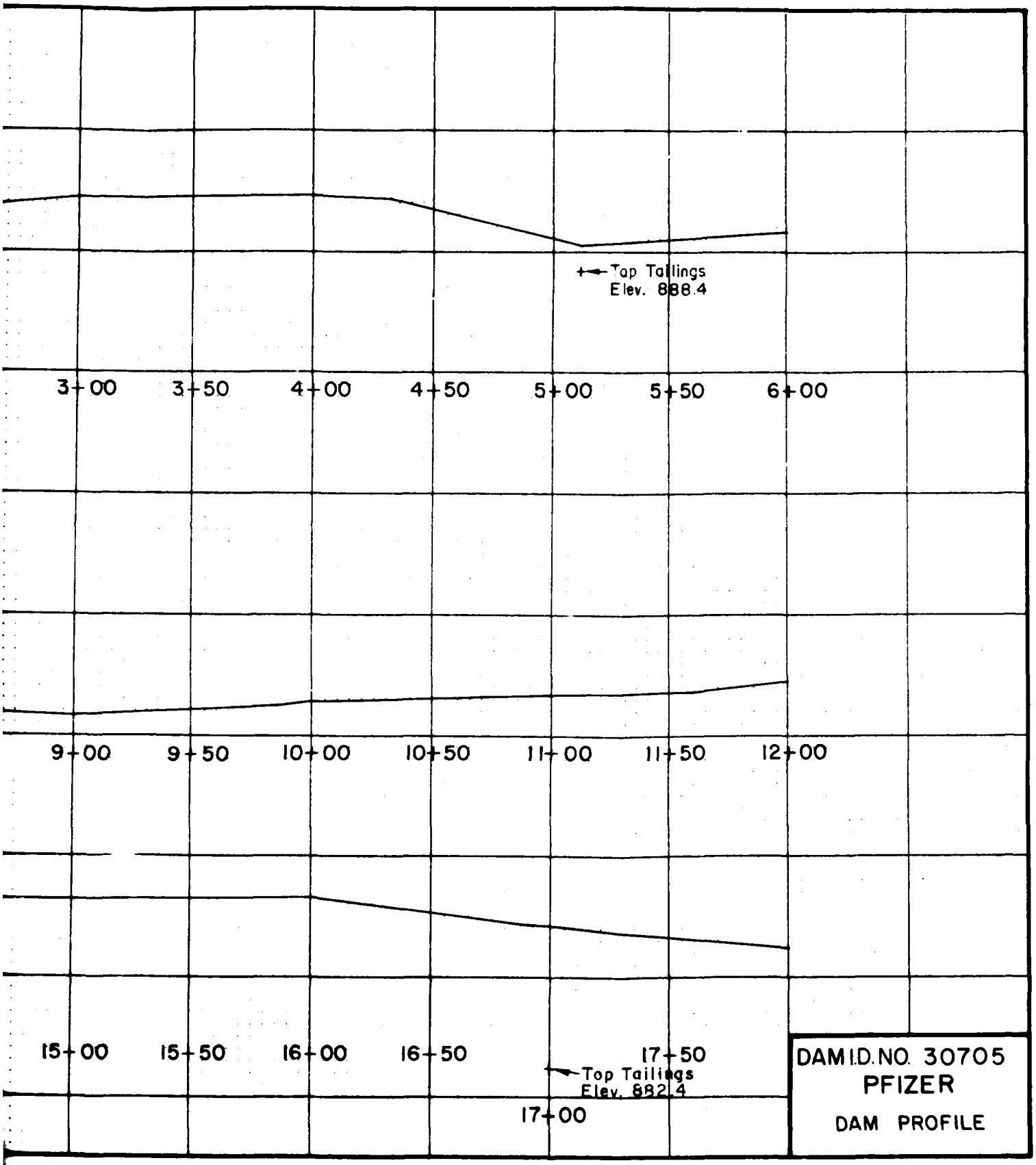

Tailings
Pond
28+47
27+60
End Dam
25+00
26+00
Top Tailings
Elev. 885.2
Ponded Water
20+00
15+00
57'
17+00
Top Tailings
Elev. 882.4
185'
Spillway
16+86
Spring-3
Elev. 849.2
18+63
Spring-1
19+05
Spring-2
DAM I.D. NO. 30705
PFIZER
PLAN
SCALE IN FEET
150 100 50 0 150

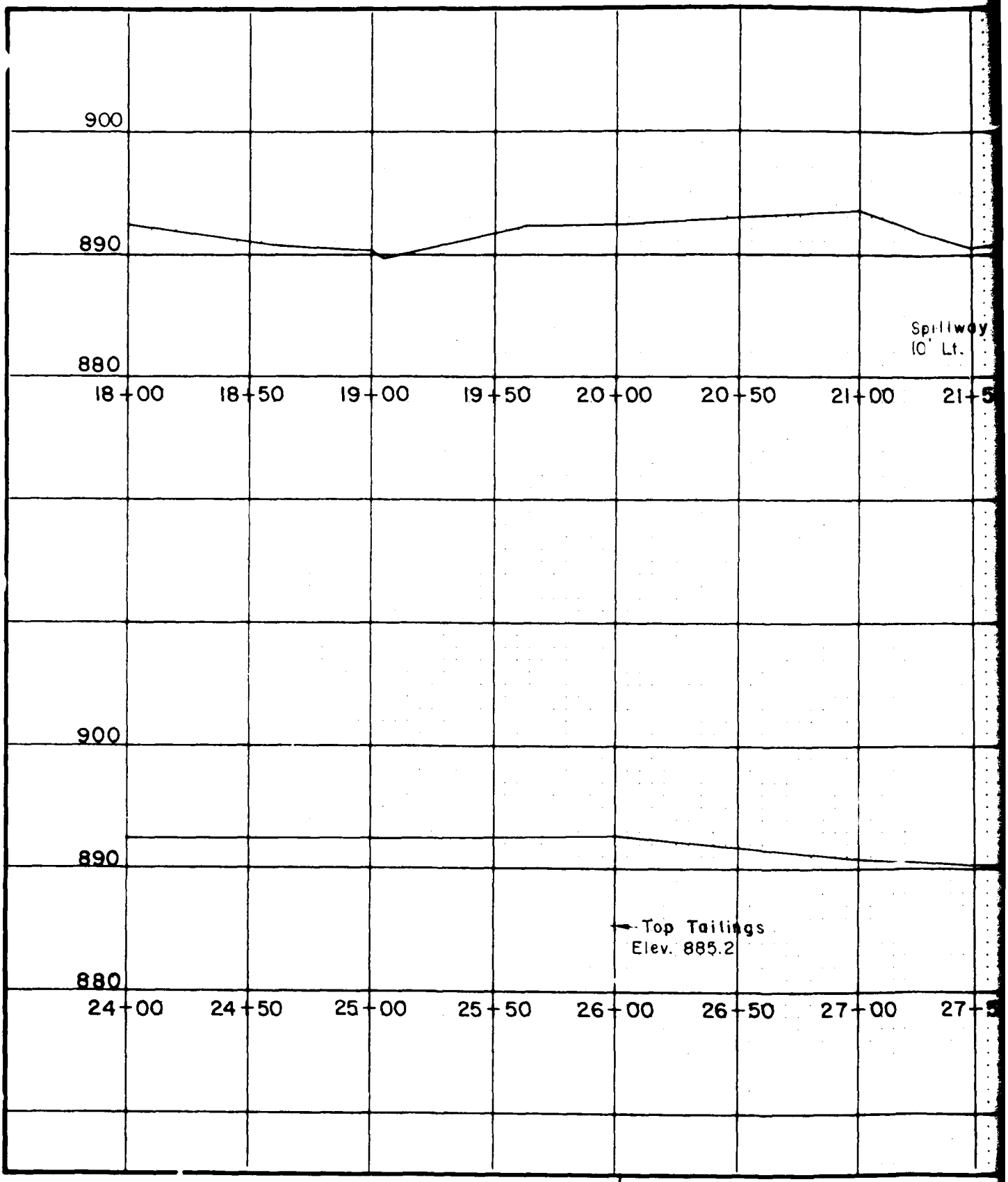
PLATE 3

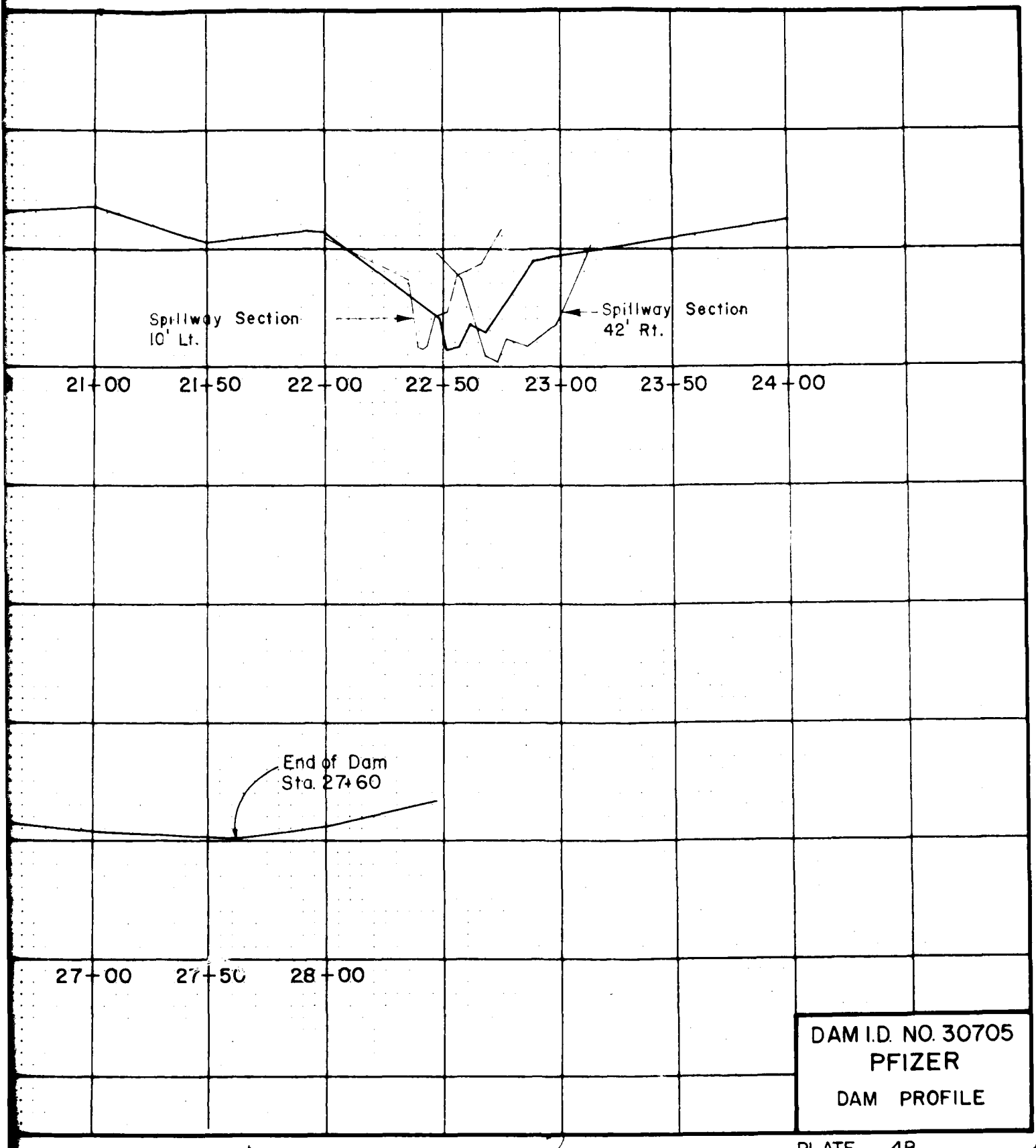

Begin Dam 0+60
900
890
880
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
900
890
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
900
890
12+00
12+50
13+00
13+50
14+00
14+50
15+00
15+50



DAM I.D. NO. 30705
PFIZER
DAM PROFILE

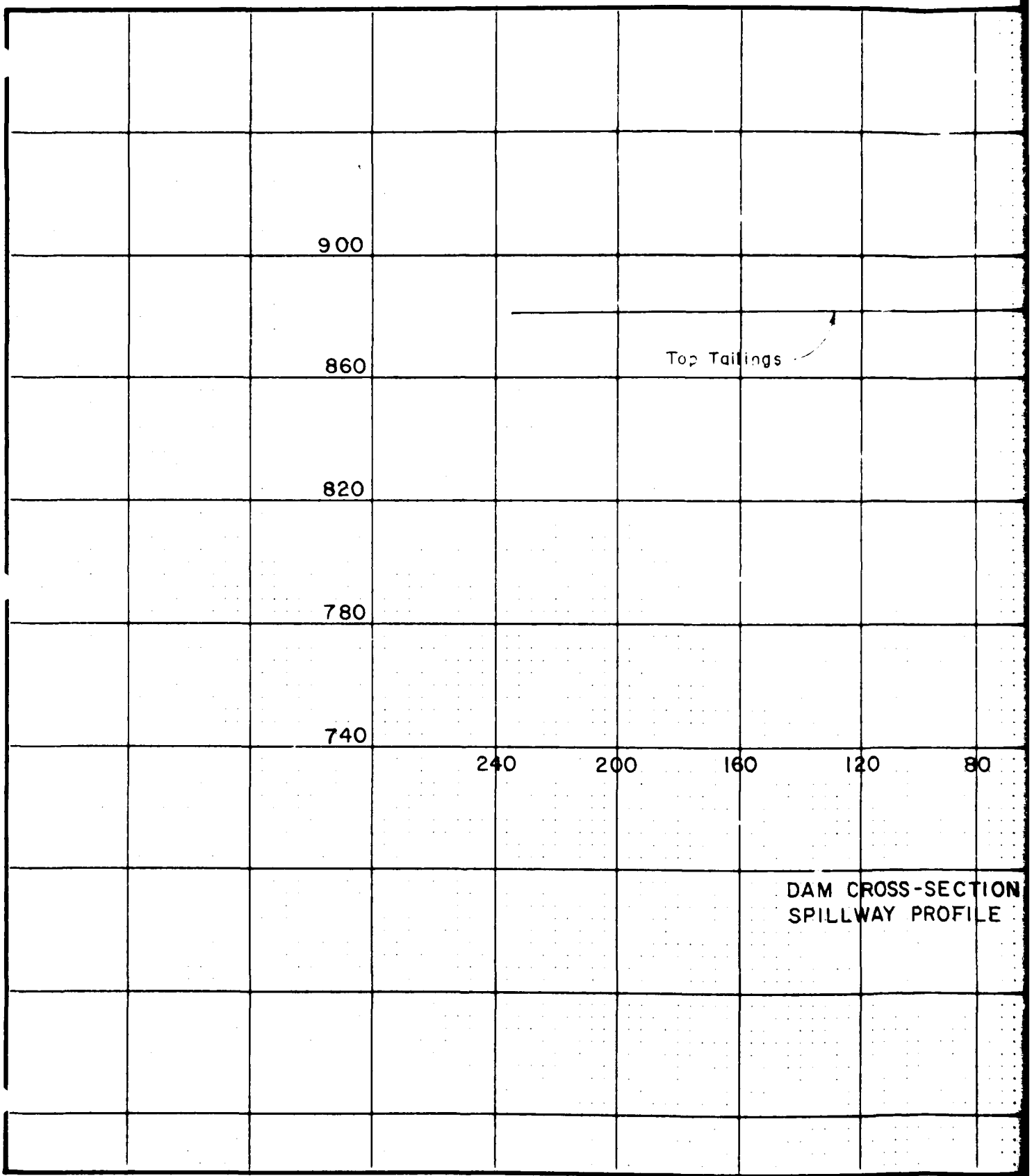
PLATE 4A

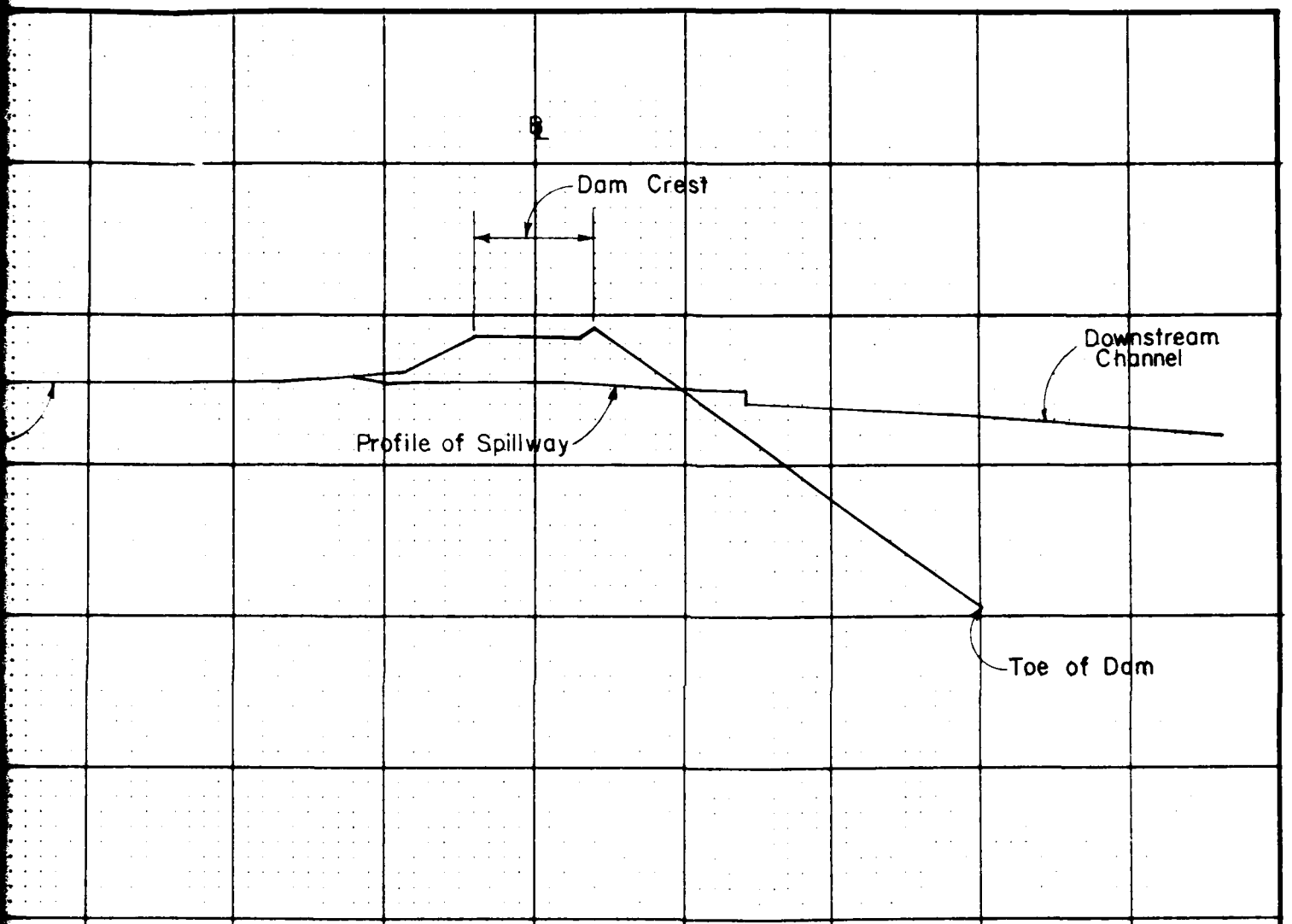

900
890
880
Spillway
10' Lt.
18+00
18+50
19+00
19+50
20+00
20+50
21+00
21+5
900
890
Top Tailings
Elev. 885.2
880
24+00
24+50
25+00
25+50
26+00
26+50
27+00
27+5



DAM I.D. NO. 30705
PFIZER
DAM PROFILE

PLATE 4B

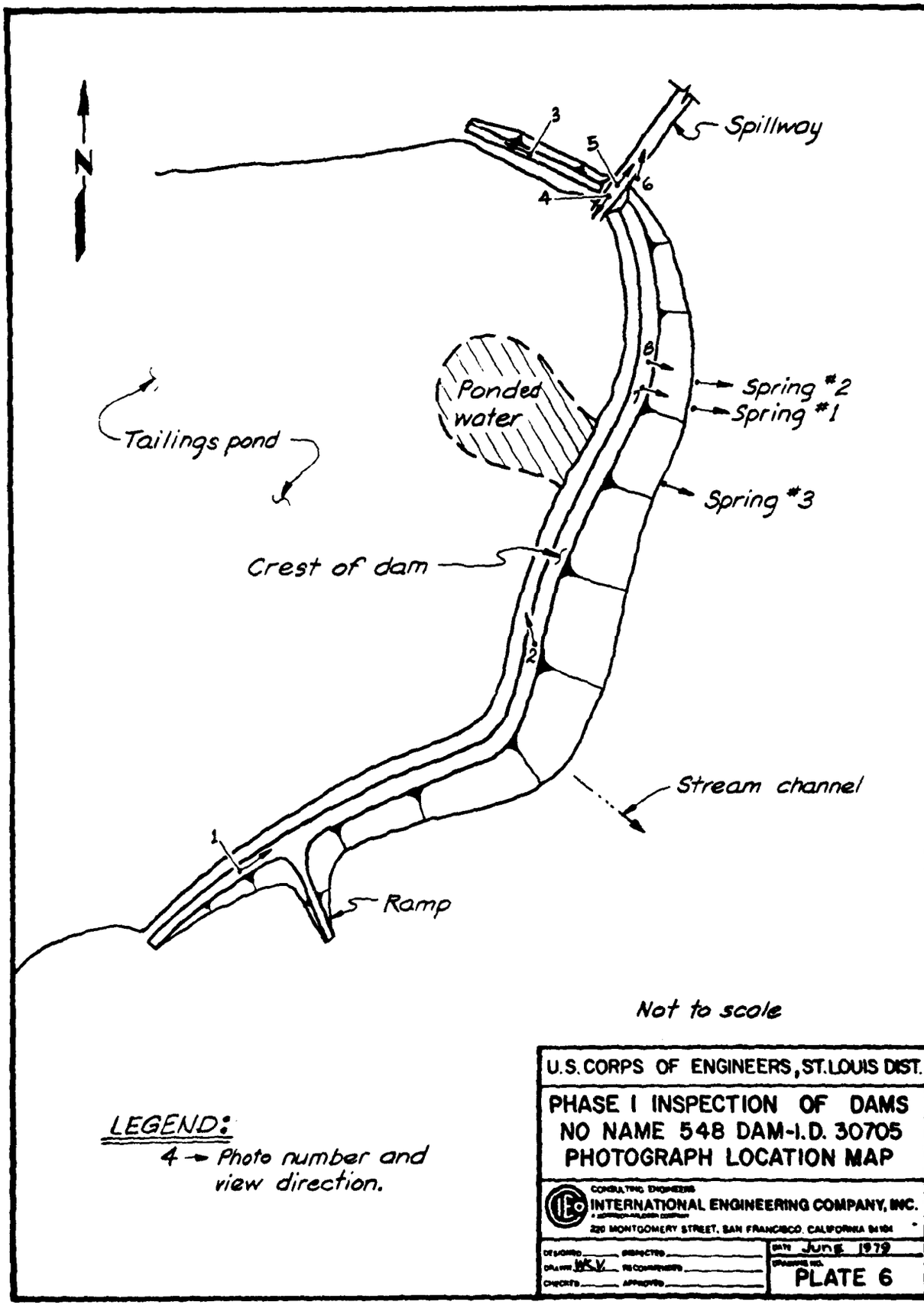

900
860
820
780
740
Top Tailings
240
200
160
120
80
DAM CROSS-SECTION
SPILLWAY PROFILE



AM CROSS-SECTION AT STATION 11+60
PILLWAY PROFILE AT STATION 22+65

DAM I.D. NO. 30705
PFIZER
DAM CROSS-SECTION
SPILLWAY PROFILE

PLATE 5



Not to scale

LEGEND:

4 → Photo number and view direction.

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NO NAME 548 DAM-I.D. 30705
PHOTOGRAPH LOCATION MAP

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED ____ INSPECTED ____
DRAWN WKV RECOMMENDED ____
CHECKED ____ APPROVED ____

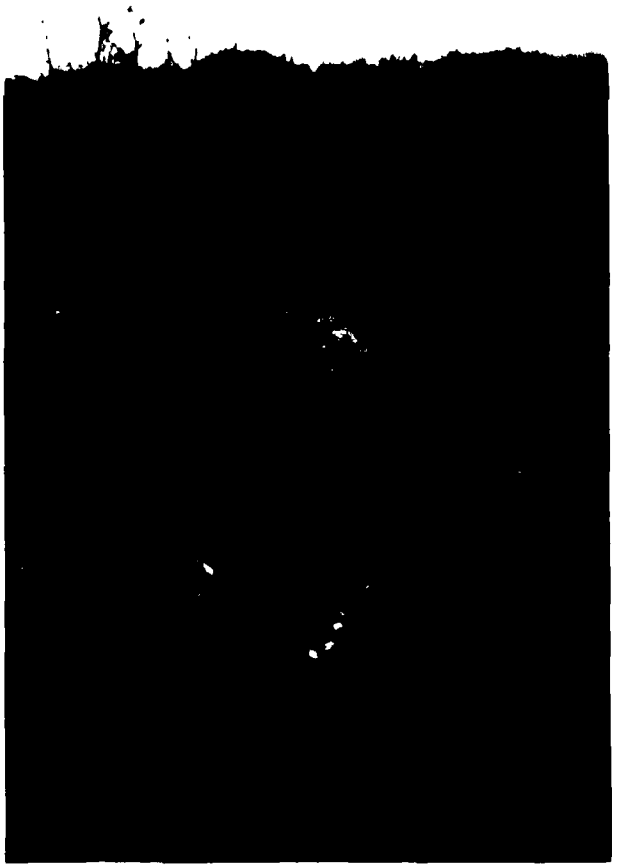
DATE June 1979

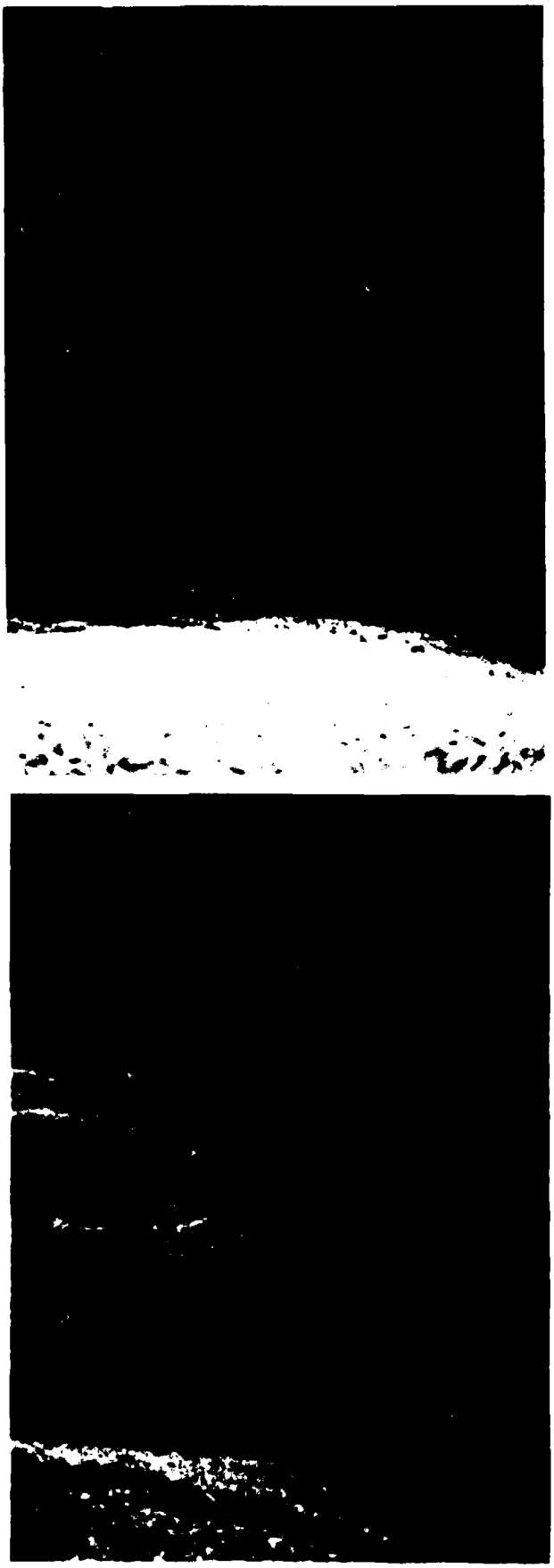
PLATE 6

PHOTOGRAPH RECORD

NO NAME 548 - PFIZER INC. DAM - I.D. NO. 30705

Photo No.	Description
1.	Downstream face and crest of dam at right abutment.
2.	Tailings impoundment towards left abutment.
3.	Crest of dam and left abutment.
4.	View upstream in spillway.
5.	View downstream in spillway.
6.	V-shaped channel downstream of spillway.
7.	Spring No. 1, at toe of dam.
8.	Spring No. 2, at toe of dam.






LMED
81